REMARKS

This Amendment is filed in response to the Non-Final Office Action mailed February 25, 2003. All objections and rejections are respectfully traversed. Reconsideration and further examination of the application, as amended, are respectfully requested.

Claims 1, 2, 4-27 and 32-42 are pending in the case. New claim 42 has been added by this amendment. Support for new claim 42 may be found in the relevant description of the Applicants' Kalman filter implementation. See, for example, page 6, line 13 through page 7, line 14 in the specification. Notably, newly added claim 42 contains similar subject matter as currently pending claim 25. No new matter is being introduced.

On pages 2 and 3 in the Office Action, the claims 1, 2, 4-27 and 32-41 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as their invention. Additionally, claim 1 was objected to as failing to provide an antecedent basis for the claimed subject matter. In response, the Applicants have amended the pending claims to eliminate ambiguities identified in the Office Action. Accordingly, each of the cited claim objection and 35 U.S.C. §112 rejections will be addressed below and discussed in view of the amended claims.

Applicants have also amended Fig. 1 and various paragraphs in the specification to correct minor errors contained therein. The list below briefly describes a summary of these changes:

- references to Fig. 2 were changed to more accurately refer to Figs. 2A and 2B,
- references to non-existent Fig. 4 were changed to refer to Fig. 3,

- on page 2, line 18, the word "of" was changed to "or,"
- on page 2, line 19, the misspelled word "detatchment" was corrected,
- on page 13, line 20, the equation for estimated error variance was corrected,
- on pages 15-16, reference numbers in the description of Fig. 3 were corrected,
- on page 16, line 21, the extraneous term "the time" was removed,
- in Fig. 1, reference number 12 was added, and
- in Fig. 1, the missing arrow on supply reel 10 was added.

On pages 3-5 in the Office Action, the claims 1, 2, 4-27 and 32-41 were rejected under 35 U.S.C. §103(a) as being obvious over the combination of Applicants' Admitted Prior Art (hereinafter "AAPA") in view of U.S. Patent No. 4,964,582 to Hermanns et al (hereinafter "Hermanns") and further in view of U.S. Patent No. 4,399,953 to Macchia. Applicants respectfully traverse the pending rejections and objection for at least the reasons set forth in this response.

Claim objection on page 2 of the Office Action

At page 2 of the Office Action, claim 1 is objected to as failing to provide an antecedent basis for the term "mechanical device." However, the term "a mechanical device" on line 10 of amended claim 1 establishes an antecedent basis for the subsequent use of the term "said mechanical device" on line 11. Therefore, the Applicants respectfully submit this claim objection should be removed.

35 U.S.C. §112, second paragraph rejections on pages 2-3 of the Office Action

Firstly, *all* the pending claims were rejected at page 3 of the Office Action on the basis that "it is not clear how the radius is calculated/estimated from just three angular

position measurements... Say the three measurements are 32 deg., 58 deg., and 5 deg., what is the amount of tape?" The relevant independent claims 1, 7, 8, 12, 14, 15, 17, 20, 25 and 42 have been amended to explicitly recite a Kalman filter including a mathematical model. Therefore, in response to the claimed input measurements, the filter calculates an estimated quantity (e.g., a radius) of tape on a reel in accordance with its mathematical model.

By way of example, the specification describes an illustrative mathematical model that may be included in the claimed Kalman filter. See, for example, the section entitled "2. The Theory" on pages 6-11 in the specification. In this model, the angular position measurements θ_r, θ_c and θ_a may be input to the Kalman filter, which manipulates these measurements in accordance with its mathematical model in order to generate an estimated quantity of tape on a reel. See page 12, line 7 through page 13, line 20 in the specification. For instance, the input measurements to the filter's model may equal θ_r = 32 deg., θ_c = 58 deg. and θ_a = 5 deg. Accordingly, the Applicants respectfully submit that this rejection should be removed.

As per claims 34-36, the Office Action asserts that there appears to be insufficient antecedent basis for "the current Kalman filter estimate." This phrase has been eliminated from the currently pending claims, thereby obviating this rejection.

As per claim 1, the Office Action states that "it is not clear what is the relationship between the tape leaving, the angular position, and the mechanical device." The term "mechanical device" has been amended and now reads: "a mechanical device used to facilitate said tape transfer process." In the invention set forth in amended claim 1, the

mechanical device is a device whose angular position changes as tape leaves the supply reel and is received at the take-up reel. For instance, in claim 4, the mechanical device is a capstan. Accordingly, Applicants respectfully submit that this rejection should be removed.

As per claims 12 and 15, the Office Action states that "in claim 12, it is not clear how 'one reel' can have a supply reel and a take up reel (same in claim 15). Where is the movement of the tape which is measured by the third transducer? And what is the third angular position a measurement of?" The amended claim 12 now recites a method for estimating a length of a tape on a tape supply reel and on a tape take-up reel. See preamble. Therefore, the tape supply and tape take-up reels are two distinct reels in the amended claim 12, and not one reel as suggested in the Office Action. Claim 15 has been amended and no longer refers to both a tape supply reel and a tape take-up reel. Instead, amended claim 15 now recites a tape reel selected from one or more tape reels.

Regarding the third transducer in amended claim 12, the Applicants respectfully note that the claim does not explicitly recite a third transducer. With regards to the third angular position measurement, the amended claim 12 recites "measuring a third angular position in response to movement of said tape." The third angular position measurement is therefore an angular position measurement of a device whose angular position changes as the claimed tape moves, e.g., from the supply reel to the take-up reel. For example, in an illustrative embodiment described in the Applicants' specification, the third angular position measurement may correspond to the angular position of a capstan that rotates as tape is transferred between the supply and take-up reels. See page 6, lines 13-19 in the

specification. Accordingly, the Applicants respectfully submit that these rejections should be removed.

As per claim 9, the Office Action states that "it is not clear where the initial estimates come from." The amended claim 9 now includes the steps of "obtaining" an initial estimate of a tape-pack radius on a supply and take-up reel, respectively. Therefore, amended claim 9's step of computing a radius of a tape pack on the supply and take-up reels is based on the *obtained* initial radius estimates. As set forth in an illustrative embodiment, these initial estimates may be based on previous radii estimates or may be obtained in other manners, as well. See, for example, page 11, lines 22-23 and page 14, line 6 in the specification. Therefore, the Applicants respectfully submit that these rejections should also be removed.

As per claim 15, the Office Action states that "it is not clear where the length of tape is located." As noted in the preamble of the amended claim 15, the claimed invention is a method for estimating a length of tape on a tape reel. The last step in the claim estimates the length of tape *on the tape reel* responsive to the measured first, second and third angular positions. Accordingly, the Applicants respectfully submit that this rejection should be removed.

As per claim 20, the Office Action states that "it is not clear how the amount of tape is calculated from just 2 variables." Firstly, the claim 20 has been amended to explicitly recite a Kalman filter including a mathematical model for calculating how much tape is on the reel. Therefore, the claimed Kalman filter's mathematical model may be

configured to manipulate the two claimed angular position measurements in order to calculate how much tape is on the reel, as presently claimed.

Secondly, the Applicants respectfully submit that the claim language does not state that the amount of tape on the reel is calculated from "just 2 variables," as alleged. Rather, the claim teaches a processor including a Kalman filter responsive to the first and second angular position measurements for calculating how much tape is on the reel. The Applicants respectfully assert that the phrase "responsive to" does not imply that the Kalman filter calculates the amount of tape on a reel solely based on two variables. In fact, the claimed filter may be responsive to other input measurements as well. For instance, see the previous discussion of the 35 U.S.C. 112 rejection applied to all pending claims. Accordingly, for at least the foregoing reasons, the Applicants respectfully submit that this rejection should be removed.

As per claim 27, the Office Action states that "steps e and f are not known (in the claim)." The steps in amended claim 27 have been relabeled, thereby obviating this rejection. Notably, support for steps in amended claim 27 may be found at the top of page 11 in the specification and at the bottom of page 12 through the middle of page 13 in the specification.

As per claim 34, the Office Action states that "it is not clear how a variable which is a number is related to the step of estimating... it is not clear of what is the individual measurement." The amended claim 34 now explicitly recites the variable is a "measured radius of tape on said reel." Furthermore, an estimate may be made of a length of tape on a tape reel, as claimed. See, for example, the estimated tape-pack radius value $\hat{r}^+$ on page

13, line 18 in the specification. Thus, the Applicants respectfully submit that this rejection should be removed.

35 U.S.C. §103(a) rejections on pages 3-5 of the Office Action

(i) Description of present invention

The present invention is generally directed to a technique for measuring a quantity of tape on a tape reel, such as a tape supply reel or a tape take-up reel. To that end, a processor receives input values measured in a tape system and uses the measurements to calculate an estimated quantity of tape on a tape reel. The input values may include at least one of: an angular position of the tape reel, an angular position of a capstan, an angular position of a tape-tension arm and an amount of tape transferred between the supply and take-up reels. As shown in Fig. 1, the processor may employ Kalman filters of various types to calculate the estimated quantity of tape on a tape reel.

(ii) Description of cited art

The cited AAPA, at the top of page 3 in the specification, teaches prior tape systems in which a tape pack radius, which is indicative of a quantity of tape on a tape reel, is calculated from measurements of the angular positions of tape reels and a capstan. However, the cited AAPA notes that the calculated tape pack radius values "are at best as accurate as the position measurements, which tend to be 'noisy.'" The cited AAPA states that certain prior tape systems have processed the noisy tape-pack radii calculations using low-pass filters.

Hermanns teaches a textile machine that spools yarn onto a "bobbin," i.e., a reel. See Abstract. The textile machine in Hermanns may include a mathematical filter (la-

beled "D" in Fig. 7) responsive to a measured bobbin diameter d_{sp} and a measured "winding time" t_{sp}. See Col. 4, lines 40-53. Alternatively, the mathematical filter (labeled "E" in Fig. 7) may be responsive to a measured bobbin diameter d_{sp} and a measured number of revolutions n_{sp}. See Col. 4, lines 40-53.

In either case, at time "K," a mathematical filter in Hermanns generates values for the initial bobbin diameter d_{oK} and the increase in bobbin radius per bobbin revolution δ_K. See Col. 4, lines 27-32 and lines 40-53. The values of d_{oK} and δ_K generated by the mathematical filter are subsequently used to calculate a diameter value d_m corresponding to the bobbin diameter during the yarn-winding process. See Col. 4, lines 53-58 and Fig. 7. The mathematical filters in Hermanns may be implemented using Kalman filters. See Col. 4, lines 25-26.

Macchia teaches a cable-processing apparatus for controlling the dynamics of winding wire and cable onto a reel or "sheave." See Col. 1, lines 6-10. Macchia teaches a technique for "driving" a pay off sheave 23 so as to minimize any difference between the instantaneous velocity (IVEL) of sheave 15 and the desired velocity (DVEL) of sheave 15. See Col. 5, lines 18-40. A servo-mechanism including a Kalman filter may be employed to minimize the velocity error (VERROR = DVEL – IVEL). See Col. 5, lines 39-44. Based on the mathematical model disclosed in Macchia, the Kalman filter is responsive to a measured instantaneous sheave velocity measurement (IVEL) and is configured to generate estimations of a sheave velocity correction variable (VCORR). See Col. 5, lines 30-59. The estimated VCORR value is used to generate a motor drive variable output signal (OUTPUT) that drives the pay off sheave 23. See Col. 5, lines 35-59.

(iii) Differences between present invention and cited art

Claim 1: The claimed invention, as amended, comprises in part:

> a first angular position transducer to ***measure a first angular position of said tape supply reel***;
> a second angular position transducer to ***measure a second angular position of said tape take-up reel***;
> a third angular position transducer to ***measure a third angular position of a mechanical device used to facilitate said tape transfer process***, said mechanical device changing said third angular position in response to said tape leaving said tape supply reel and being received by said tape take-up reel;
> ***a processor having a Kalman filter, said Kalman filter responsive to one or both of said first and second angular position measurements and also responsive to said third angular position measurement, said Kalman filter including a mathematical model for calculating an estimate of one or both of a supply radius of a tape pack on said tape supply reel and a take-up radius of a tape pack on said tape take-up reel***;

Amended claim 1 recites a processor having a Kalman filter that calculates an estimate of one or both of a supply radius of a tape pack on a tape supply reel and a take-up radius of a tape pack on a tape take-up reel. The Kalman filter is responsive to one or both of first and second angular position measurements of the supply and take-up reels, respectively, and the filter is also responsive to a third angular position measurement of a mechanical device.

The Office Action alleges that the combination of the cited AAPA in view of Hermanns and Macchia, taken as a whole, would render obvious the above-noted elements of claim 1. The Office Action appears to support such a conclusion based on the fact that "the admitted prior art... discloses substantially all the claimed features including a tape system having a supply reel, a take-up reel, a capstan, tension arms, a servo

system" and "the admitted prior art already uses filters and both Hermanns et al and Macchia suggests the use of Kalman filters, therefore making the combination obvious to one of ordinary skill in the art." See pages 3-4 in the Office Action.

The Applicants respectfully submit that amended claim 1 is not obvious in view of the art of record, whether taken singly or in their totality. There is no question that "Kalman filters for minimizing errors in predictive computations are old and well known" as asserted on page 3 of the Office Action. Admittedly, Kalman filters were used in numerous systems at the time of the invention, such as in Hermanns' textile machine and in Macchia's cable-processing apparatus. In each of these cases, specialized mathematical models were developed so each respective Kalman filter could generate state-variable estimations appropriate to the system in which it is embedded. For example, the Kalman filter in Macchia is configured with a mathematical model that generates estimations of a sheave velocity correction variable (VCORR) in a cable-processing apparatus. See Macchia, Col. 5, lines 40-59. Similarly, the Kalman filter in Hermanns is configured with a mathematical model that generates estimations of an initial bobbin diameter (d_{oK}) and a yarn thickness (δ_K) in a textile machine. See Hermanns, Col. 4, lines 16-26.

However, neither the Kalman filter in Hermanns nor Macchia is configured to calculate an estimated value of a radius of a tape pack on a tape reel, like the Kalman filter recited in amended claim 1. Firstly, the cited prior-art Kalman filters output state-variable estimations (e.g., VCORR, d_{oK} and δ_K) that would make no sense in a tape system. That is, a Kalman filter configured to estimate a sheave velocity correction, a yarn

thickness or an initial bobbin diameter would have no utility in a tape system, such as in the cited AAPA tape system. Therefore, the Kalman filters in Hermanns and Macchia cannot anticipate or render obvious the Kalman filter in amended claim 1 which explicitly calculates an estimate of a radius of a tape pack in a tape system.

Secondly, the prior-art Kalman filters are responsive to different input measurements than the claimed Kalman filter. For example, a Kalman filter in Hermanns is responsive to a measured bobbin diameter (d_{sp}) and to one of a measured winding time (t_{sp}) and a measured number of revolutions (n_{sp}). See Hermanns, Col. 4, lines 40-53. A Kalman filter in Macchia is responsive to an instantaneous sheave velocity measurement (IVEL). See Macchia, Col. 5, lines 30-59. In contrast, the claimed Kalman filter is responsive to a completely different set of input measurements specific to a tape system, as explicitly recited in amended claim 1. Accordingly, one of ordinary skill in the art of designing a cable-processing apparatus (Macchia) or a textile machine (Hermanns) would not contemplate a Kalman filter which is input angular position measurements of one or both of tape supply and take-up reels and of a mechanical device used to facilitate a tape-transfer process, as recited in amended claim 1.

As noted, the Kalman filters taught in Hermanns and Macchia are not configured to operate in a tape system. Thus, simple substitution of the low-pass filter in the AAPA tape system with either of these prior-art Kalman filters cannot result in the Applicants' amended claim 1. Further, there is no apparent reason why an artisan in the field of tape systems would even look to the teachings of Hermanns or Macchia for implementing a Kalman filter in place of the low-pass filter in the AAPA tape system. In fact, a designer

of the AAPA tape system likely would not be in possession of references pertaining to textile machines and cable-processing apparatuses. Moreover, because the Kalman filters in Hermanns and Macchia are implemented in environments completely unrelated to a tape system, one of ordinary skill in the art would find no motivation in the cited references to modify either of these prior-art Kalman filters to accept tape-system input measurements and output estimated quantities of tape, as recited in amended claim 1.

For at least the foregoing reasons, Applicants respectfully urge that amended claim 1 is allowable over the art of record since the cited references, taken alone or in combination, do not disclose a tape system employing a Kalman filter as recited in amended claim 1.

Claim 2: The claimed invention, as amended, comprises in part:

> ***a supply Kalman filter*** responsive to said first angular position measurement and said third angular position measurement;
> ***a take-up Kalman filter*** responsive to said second angular position measurement and said third angular position measurement.

Amended claim 2 recites different supply and take-up Kalman filters. The Macchia and Hermanns references do not disclose two different Kalman filters implemented in the same system. The cited AAPA tape system does not disclose Kalman filters at all. Furthermore, the cited references do not teach or otherwise disclose Kalman filters responsive to the specific angular position measurements recited in amended claim 2. Therefore, because the two claimed Kalman filters are absent in each of the cited prior art references, no combination of the prior art of record disclose the two Kalman filters explicitly recited in amended claim 2.

Applicants respectfully submit that claim 2, as amended, is not only allowable for the reasons previously discussed in regards to independent claim 1, but is also allowable on its own merits.

Claim 4: The claimed invention, as amended, comprises in part:

> wherein ***said mechanical device is a capstan***, said tape contacting said capstan and said capstan rotating as said tape transfers from said tape supply reel to said tape take-up reel.

Amended claim 4 teaches that the mechanical device in amended claim 1 is a capstan. The Macchia and Hermanns references do not disclose a capstan. While the cited AAPA generally discloses a capstan in a tape system, the AAPA does not teach or otherwise disclose measuring a third angular position of the capstan which is input to a Kalman filter, as recited in amended claim 4. Consequently, no combination of the prior art of record discloses amended claim 1's mechanical device as a capstan.

Therefore, Applicants respectfully submit that claim 4, as amended, is not only allowable for the reasons previously discussed in regards to independent claim 1, but is also allowable on its own merits.

Claim 5: The claimed invention, as amended, comprises in part:

> ***said third angular position transducer further comprises:***
> ***an encoder responsive to an angular position of a capstan.***

The Macchia and Hermanns references do not disclose a capstan. While the cited AAPA generally discloses a capstan in a tape system, the AAPA does not teach or otherwise disclose a Kalman filter whose inputs include a measured angular position of an encoder responsive to an angular position of a capstan, as recited in the amended claim 5.

Consequently, no combination of the prior art of record discloses a Kalman filter that receives input measurements from a third angular position transducer comprising an encoder responsive to an angular position of a capstan.

Therefore, Applicants respectfully submit that claim 5, as amended, is not only allowable for the reasons previously discussed in regards to independent claim 1, but is also allowable on its own merits.

Claim 6: The claimed invention, as amended, comprises in part:

> ***a tape length estimator responsive to said Kalman filter*** to determine the amount of tape available for a record operation..

The Macchia and Hermanns references do not disclose a tape length estimator responsive to a Kalman filter. Further, the cited AAPA tape system does not disclose a tape length estimator. Thus, because none of the cited art teaches a tape length estimator, no combination of the prior art of record can disclose the tape length estimator recited in amended claim 6.

Therefore, Applicants respectfully submit that claim 6, as amended, is not only allowable for the reasons previously discussed in regards to independent claim 1, but is also allowable on its own merits.

Claim 7: The claimed invention, as amended, comprises in part:

> a first transducer to measure a first angular position of said tape supply reel;
> a second transducer to measure a second angular position of said tape take-up reel;
> a third transducer responsive to movement of said tape as said tape is transferred from said supply reel to said take-up reel;

a processor having a Kalman filter, said Kalman filter responsive to one or both of said first and second angular position measurements and also responsive to a third measurement by said third transducer, said Kalman filter including a mathematical model for determining an estimate of one or both of a supply radius of a tape pack on said tape supply reel and a take-up radius of a tape pack on said tape take-up reel for calculating said available length of tape;

As previously noted with regards to amended claim 1, the Kalman filters in the cited prior art: (1) are responsive to input measurements (e.g., IVEL, d_{sp} and n_{sp}) which are not present in the claimed tape system, and (2) generate output estimations for state variables (e.g., VCORR, d_{oK} and δ_K) which are not present in the claimed tape system. Therefore, the cited AAPA, Hermanns and Macchia, whether taken alone or in combination, cannot teach a Kalman filter responsive to the specific tape-system input measurements enumerated in amended claim 7, where the Kalman filter determines an output estimate of a tape-pack radius in a tape system, as recited in amended claim 7.

In addition, the cited art references, taken alone or in combination, also do not teach or otherwise suggest using a tape-pack radius determined by a Kalman filter to calculate an available length of tape, as explicitly recited in amended claim 7.

Moreover, for the reasons previously set forth in the discussion of amended claim 1, one of ordinary skill in the art would not be motivated to combine the cited prior art references. Accordingly, the Applicants respectfully submit that the amended claim 7 is allowable over the cited references, whether taken singly or in combination.

Claim 8: The claimed invention, as amended, comprises in part:

> ***measuring a first angular position of said supply reel;***
> ***measuring a second angular position of said take-up reel;***
> ***measuring a third angular position of a capstan*** that rotates to transfer the tape between said tape supply and take-up reels; and,
> ***estimating, by a processor that employs a Kalman filter including a mathematical model, a radius of a tape pack on said supply reel and a radius of a tape pack on said take-up reel, in response to said first angular position of said tape supply reel, said second angular position of said tape take-up reel, and said third angular position of said capstan.***

As previously noted with regards to amended claim 1, the Kalman filters in the cited prior art: (1) are responsive to input measurements (e.g., IVEL, d_{sp} and n_{sp}) which are not present in the claimed tape system, and (2) generate output estimations for state variables (e.g., VCORR, d_{OC} and δ_G) which are not present in the claimed tape system. Therefore, the cited AAPA, Hermanns and Macchia, whether taken alone or in combination, cannot teach a Kalman filter responsive to the specific tape-system input measurements enumerated in amended claim 8, where the Kalman filter estimates a tape-pack radius in a tape system, as recited in amended claim 8.

Moreover, for the reasons previously set forth in the discussion of amended claim 1, one of ordinary skill in the art would not be motivated to combine the cited prior art references. Accordingly, the Applicants respectfully submit that the amended claim 8 is allowable over the cited references, whether taken singly or in combination.

Claim 9: The claimed invention, as amended, comprises in part:

> ***obtaining an initial estimate of said radius of a tape pack on said supply reel;***
> ***obtaining an initial estimate of a radius of a tape pack on said take-up reel;*** and,

computing said radius of said tape pack on said supply reel and said radius of said tape pack on said take-up reel based on said initial estimate of said radius of a tape pack on said supply reel, said initial estimate of a radius of a tape pack on said take-up reel, said first angular position, said second angular position and said third angular position.

The cited AAPA tape system, Macchia and Hermanns references do not teach or otherwise disclose obtaining an initial estimate of a radius of a tape pack on supply and take-up reels. Moreover, the prior art of record does not teach using such initial estimates to compute the radius of a tape pack on a supply reel and a take-up reel. Because the cited prior art references, taken alone or in combination, fail to disclose these material elements of amended claim 9, the Applicants respectfully submit that claim 9, as amended, is not only allowable for the reasons previously discussed in regards to independent claim 8, but is also allowable on its own merits.

Claim 10: The claimed invention, as amended, comprises in part:

measuring said first angular position at *a first regular time interval*;
measuring said second angular position at *a second regular time interval*;
and,
measuring said third angular position at *a third regular time interval*.

The cited AAPA tape system, Macchia and Hermanns references do not teach or otherwise disclose taking three different angular position measurements. Furthermore, the cited prior art references do not disclose taking such measurements at respective regular time intervals. The Office Action alleges that "the step-by-step process of collecting data points, such as when to update the data and the time interval in between, etc., would have been within the level of one of ordinary skill in the art." See page 4 in the

Office Action. However the Office Action does not refer to any source of prior art as evidence thereof. Accordingly, the Applicants respectfully disagree with this assertion as applied to the claimed angular position measurements and request a specific prior art reference be presented if this assertion is maintained in future correspondences.

Because the cited prior art references, taken alone or in combination, fail to disclose the claimed time intervals, the Applicants respectfully submit that claim 10, as amended, is not only allowable for the reasons previously discussed in regards to independent claim 8, but is also allowable on its own merits.

Claim 11: The claimed invention, as amended, comprises in part:

> ***choosing said first regular time interval, said second regular time interval and said third regular time interval each to be approximately 20 milliseconds.***

The cited AAPA tape system, Macchia and Hermanns references do not teach or otherwise disclose the three claimed time intervals equal to approximately 20 milliseconds. In fact, as noted with regards to amended claim 10, none of the cited prior art references even disclose taking measurements at regular time intervals. The Office Action alleges that the claimed time intervals "would have been determined through routine engineering experimentation and optimization." See page 4 in the Office Action. However, the Office Action does not refer to any source of prior art as evidence thereof. Accordingly, the Applicants respectfully disagree with this assertion as applied to the specific time intervals in amended claim 11 and request a specific prior art reference be presented if this assertion is maintained in future correspondences.

Because the cited prior art references, taken alone or in combination, fail to disclose the specific claimed time intervals, the Applicants respectfully submit that claim 11, as amended, is not only allowable for the reasons previously discussed in regards to claim 10, but is also allowable on its own merits.

Claim 12: The claimed invention, as amended, comprises in part:

> measuring ***a first angular position of said tape supply reel***;
> measuring ***a second angular position of said tape take-up reel***;
> measuring ***a third angular position in response to movement of said tape***; and,
> ***estimating, by a processor that employs a Kalman filter including a mathematical model, said length of tape on said tape supply and tape take-up reels, in response to said first angular position of said tape supply reel, said second angular position of said tape take-up reel, and said third angular position measured in response to movement of said tape.***

As previously noted with regards to amended claim 1, the Kalman filters in the cited prior art: (1) are responsive to input measurements (e.g., IVEL, d_{sp} and n_{sp}) which are not present in the claimed tape system, and (2) generate output estimations for state variables (e.g., VCORR, d_{oK} and δ_K) which are not present in the claimed tape system. Therefore, the cited AAPA, Hermanns and Macchia, whether taken alone or in combination, cannot teach a Kalman filter responsive to the specific tape-system input measurements enumerated in amended claim 12, where the Kalman filter estimates a length of tape on tape supply and take-up reels, as recited in amended claim 12.

Moreover, for the reasons previously set forth in the discussion of amended claim 1, one of ordinary skill in the art would not be motivated to combine the cited prior art

references. Accordingly, the Applicants respectfully submit that the amended claim 12 is allowable over the cited references, whether taken singly or in combination.

Claim 13: The claimed invention, as amended, comprises in part:

> said first angular position transducer comprises ***a first optical encoder*** responsive to said first angular position of the tape supply reel;
> said second angular position transducer comprises ***a second optical encoder*** responsive to said second angular position of the tape take-up reel; and
> said third angular position transducer comprises ***a third optical encoder*** responsive to said third angular position of the mechanical device.

The Macchia and Hermanns references do not disclose three optical encoders. While the cited AAPA tape system discloses optical encoders in general, the AAPA does not teach or otherwise disclose optical encoders responsive to the angular positions of a tape supply reel, tape take-up reel and mechanical device, whereby the angular positions are input to a Kalman filter, as recited in the claimed invention. Consequently, no combination of the prior art of record discloses the three optical encoders as claimed.

Therefore, Applicants respectfully submit that claim 13, as amended, is not only allowable for the reasons previously discussed in regards to independent claim 1, but is also allowable on its own merits

Claims 14 and 16: Claim 14, as amended, comprises in part:

> measuring ***a first angular position of said tape supply reel***;
> measuring ***a second angular position of said tape take-up reel***;
> measuring ***a third angular position of a capstan*** engaging the tape as said tape is transferred from said tape supply reel to said tape take-up reel; and,
> ***estimating said length of tape by a processor employing a Kalman filter including a mathematical model, said Kalman filter responsive to at least one of said first and second angular positions and also responsive to said third angular position.***

As previously noted with regards to amended claim 1, the Kalman filters in the cited prior art: (1) are responsive to input measurements (e.g., IVEL, d_{sp} and n_{sp}) which are not present in the claimed tape system, and (2) generate output estimations for state variables (e.g., VCORR, d_{oK} and δ_K) which are not present in the claimed tape system. Therefore, the cited AAPA, Hermanns and Macchia, whether taken alone or in combination, cannot teach a Kalman filter responsive to the specific tape-system input measurements enumerated in amended claim 14, where the Kalman filter estimates a length of tape in a tape system, as recited in amended claim 14.

Moreover, for the reasons previously set forth in the discussion of amended claim 1, one of ordinary skill in the art would not be motivated to combine the cited prior art references. Accordingly, the Applicants respectfully submit that the amended claim 14 is allowable over the cited references, whether taken singly or in combination. Because amended claim 16 depends on claim 14, Applicants respectfully submit that claim 16 is also allowable for at least the same reasons.

Claim 15: The claimed invention, as amended, comprises in part:

> ***selecting said tape reel from one or more tape reels;***
> measuring ***a first angular position of said tape reel;***
> measuring ***a second angular position of a capstan engaging said tape;***
> measuring ***a third angular position of a tape tension arm;*** and
> ***estimating said length of said tape by a processor employing a Kalman filter including a mathematical model, said Kalman filter responsive to said measured first, second and third angular positions.***

As previously noted with regards to amended claim 1, the Kalman filters in the cited prior art: (1) are responsive to input measurements (e.g., IVEL, d_{sp} and n_{sp}) which

are not present in the claimed tape system, and (2) generate output estimations for state variables (e.g., VCORR, d_{oK} and δ_K) which are not present in the claimed tape system. Therefore, the cited AAPA, Hermanns and Macchia, whether taken alone or in combination, cannot teach a Kalman filter responsive to the specific tape-system input measurements enumerated in amended claim 15, where the Kalman filter estimates a length of tape in a tape system, as recited in amended claim 15.

In addition, the cited art references, taken alone or in combination, also do not teach or otherwise suggest selecting a tape reel from one or more tape reels, as explicitly recited in amended claim 15.

Moreover, for the reasons previously set forth in the discussion of amended claim 1, one of ordinary skill in the art would not be motivated to combine the cited prior art references. Accordingly, the Applicants respectfully submit that the amended claim 15 is allowable over the cited references, whether taken singly or in combination.

Claims 17-19: Claim 17, as amended, comprises in part:

> measuring ***a first angular position of said tape reel;***
> measuring ***a second angular position of a cylindrical member*** engaging and rotating with the tape as the tape moves along a tape path;
> measuring ***a third angular position of a tension arm*** engaging the tape between said reel and said cylindrical member; and,
> ***estimating how much tape is on said tape reel by a processor employing a Kalman filter including a mathematical model, said Kalman filter responsive to said first angular position of said tape reel, said second angular position of said cylindrical member, and said third angular position of said tension arm.***

As previously noted with regards to amended claim 1, the Kalman filters in the cited prior art: (1) are responsive to input measurements (e.g., IVEL, d_{ep} and n_{ep}) which

are not present in the claimed tape system, and (2) generate output estimations for state variables (e.g., VCORR, d_{0K} and δ_K) which are not present in the claimed tape system. Therefore, the cited AAPA, Hermanns and Macchia, whether taken alone or in combination, cannot teach a Kalman filter responsive to the specific tape-system input measurements enumerated in claim 17, where the Kalman filter estimates how much tape is on a tape reel in a tape system, as recited in amended claim 17.

Moreover, for the reasons previously set forth in the discussion of amended claim 1, one of ordinary skill in the art would not be motivated to combine the cited prior art references. Accordingly, the Applicants respectfully submit that claim 17 is allowable over the cited references, whether taken singly or in combination. Because claims 18 and 19 depend on claim 17, Applicants respectfully submit that claims 18 and 19 are allowable for at least the same reasons.

Claims 20-24: Claim 20, as amended, comprises in part:

> a cylindrical member engaging the tape at a position along the tape path that establishes a tape path length from the reel, said cylindrical member engaging said tape, said cylindrical member rotating as the tape is moved along the tape path;
>
> a first angular position transducer for ***measuring a first angular position of said reel*** as the tape is moved along the tape path;
>
> a second angular position transducer for ***measuring a second angular position of the cylindrical member*** as the tape is moved along the tape path; and
>
> ***a processor including a Kalman filter responsive to the first and second angular positions measured by the first and second angular position transducers, said Kalman filter including a mathematical model for calculating how much tape is on said reel.***

As previously noted with regards to amended claim 1, the Kalman filters in the cited prior art: (1) are responsive to input measurements (e.g., IVEL, d_{sp} and n_{sp}) which

are not present in the claimed tape system, and (2) generate output estimations for state variables (e.g., VCORR, d_{oK} and δ_K) which are not present in the claimed tape system. Therefore, the cited AAPA, Hermanns and Macchia, whether taken alone or in combination, cannot teach a Kalman filter responsive to the specific tape-system input measurements enumerated in claim 20, where the Kalman filter calculates how much tape is on a reel in a tape system, as recited in claim 20.

Moreover, for the reasons previously set forth in the discussion of amended claim 1, one of ordinary skill in the art would not be motivated to combine the cited prior art references. Accordingly, the Applicants respectfully submit that claim 20 is allowable over the cited references, whether taken singly or in combination. Because claims 21-24 depend on claim 20, Applicants respectfully submit that claims 21-24 are allowable for at least the same reasons.

Claims 25-27: Claim 25, as amended, comprises in part:

> ***measuring the amount of rotation by the reel*** as the tape is unwound from or wound onto the reel;
> ***measuring the amount of movement of the tape along the tape path*** as the tape is unwound from or wound onto the reel, the movement of the tape measured at a position along the tape path that establishes a tape path length from the reel; and,
> ***calculating, by a processor that employs a Kalman filter including a mathematical model, how much tape is on the reel in response to the measured amount of rotation by the reel and the measured amount of movement of the tape.***

As previously noted with regards to amended claim 1, the Kalman filters in the cited prior art: (1) are responsive to input measurements (e.g., IVEL, d_{sp} and n_{sp}) which are not present in the claimed tape system, and (2) generate output estimations for state

variables (e.g., VCORR, d_{oK} and δ_K) which are not present in the claimed tape system. Therefore, the cited AAPA, Hermanns and Macchia, whether taken alone or in combination, cannot teach a Kalman filter responsive to the specific tape-system input measurements enumerated in claim 25, where the Kalman filter calculates how much tape is on a reel in a tape system, as recited in claim 25.

Moreover, for the reasons previously set forth in the discussion of amended claim 1, one of ordinary skill in the art would not be motivated to combine the cited prior art references. Accordingly, the Applicants respectfully submit that claim 25 is allowable over the cited references, whether taken singly or in combination. Because claims 26-27 depend on claim 25, Applicants respectfully submit that claims 26-27 are allowable for at least the same reasons. With regard to claim 27, Applicants note that the claim also includes the patentable subject matter that will be discussed below in regards to claims 34-41.

Claims 32-33: Claim 32, as amended, comprises "***an encoder responsive to an angular position of a supply reel tension arm***" and claim 33, as amended, comprises "***an encoder responsive to an angular position of a take-up reel tension arm.***"

The Macchia and Hermanns references do not disclose a supply reel tension arm or a take-up reel tension arm. While the cited AAPA tape system generally discloses tape tension arms, the cited AAPA does not teach or otherwise disclose a transducer comprising an encoder responsive to a tape tension arm's angular position which is input to a Kalman filter, as recited in the claimed invention. Consequently, no combination of the

prior art of record can disclose a third angular position transducer comprising the encoders explicitly recited in claims 32 and 33.

Therefore, Applicants respectfully submit that claims 32-33, as amended, are not only allowable for the reasons previously discussed in regards to independent claim 1, but are also allowable on their own merits.

Claim 34: Claim 34, as amended, comprises in part:

a. obtaining a measured radius of tape on said reel;
b. ***selecting a minimum and maximum acceptable measurement value of said measured radius;***
c. ***if said measured radius is less than the minimum acceptable value of said radius, then setting the value of the measured radius to the minimum acceptable measurement value of said radius;***
d. ***if said measured radius is greater than the maximum acceptable value of said radius, then setting the value of the measured radius to the maximum acceptable measurement value of said radius;***
e. ***selecting a maximum acceptable variance*** corresponding to said measured radius;
f. ***calculating a measured variance*** based on said measured radius
g. ***determining if said measured variance is greater than said maximum acceptable variance;***
h. ***determining if a three sigma-interval around said measured radius is not at least partially included within an interval from said minimum to said maximum acceptable measurement values;*** and,
i. ***if the determinations in steps g OR h prove true, ignoring the measured radius and estimating said length of said tape on said reel based on one or more previous estimates of said length of said tape on said reel.***

The amended claim 34 teaches a method that first determines whether a measured radius (e.g., r_m) of tape on a reel is within a bounded range of acceptable measured radius values (e.g., r_{min} and r_{max}). If not, then the value of the measured radius is set equal to an appropriate one of a minimum and maximum acceptable radius values. Next, the method determines whether the measured radius value should be ignored and an estimate of the

length of tape on the reel may be based on one or more previous estimates of the length of tape on the reel. In amended claim 34, the measured radius value is ignored if its corresponding measured variance (e.g., σ^2_m) is greater than a maximum acceptable variance OR if a three sigma (e.g., $3\sigma_m$) interval around the measured radius is not at least partially included within the bounded range of acceptable measured radius values.

Although the cited AAPA tape system obtains a measured radius of tape on a reel, the prior-art tape system does not determine whether the measured radius is within a bounded range of acceptable measured radius values, as recited in the claimed invention. Furthermore, the measured radius in the cited AAPA is never ignored based on the criteria explicitly recited in steps (e) through (i) in amended claim 34. Instead, every measured radius value in the AAPA is input to a low-pass filter which, by definition, is used to attenuate high-frequency noise components from *each measurement* in a sequence of radius measurements. Thus, in contrast with the claimed invention, the AAPA tape system does not ignore any measured radius measurements nor does the prior-art tape system test the radius measurements against a bounded range of values.

The cited Hermanns and Macchia references do not remedy the deficiencies of the cited AAPA tape system. Namely, there is no disclosure in either of these references that hints or otherwise suggests of determining whether a measured radius is within a bounded range of acceptable measured radius values, ignoring a measured radius if its corresponding measured variance is greater than a maximum acceptable variance, and ignoring a measured radius if a three sigma interval around the measured radius is not at least partially included within a bounded range of acceptable values. Accordingly, be-

cause none of the prior art of record discloses the aforementioned steps explicitly recited in amended claim 34, no combination of the references can result in the claimed invention.

Page 4 of the Office Action states that "the minimum and maximum values and the three-sigma intervals are old and well known in the field of data and statistical analysis so that unreasonable data does not contaminate and reduce the accuracy of the analysis." Applicants respectfully submit that minimum and maximum values have not been used in conjunction with a measured radius of a tape on a reel, as claimed. Nor have three-sigma intervals been employed in a tape system as recited in amended claim 34. It is important to note that the claimed use of minimum and maximum values, variances, and three-sigma intervals is not directed to the generalized field of "data and statistical analysis," as the Office Action asserts. Here, these claimed values are used to make specific determinations for estimating a length of tape on a reel. Consequently, the existence of such values in unrelated statistical fields is legally insufficient to render obvious their specifically claimed uses in a tape system. Accordingly, the Applicants respectfully disagree with this generalized assertion and request a specific prior art reference be presented if this assertion is maintained in future correspondences.

For at least the foregoing reasons, the Applicants respectfully submit that independent claim 34 is allowable in its present form.

Claim 35: Claim 35, as amended, comprises in part:

a. ***choosing a variable to be measured, said variable related to estimating said length of tape on said reel;***
b. ***selecting a maximum acceptable variance*** corresponding to said variable;
c. ***obtaining an individual measurement of said variable;***
d. ***determining if said individual measurement's variance is greater than said maximum acceptable variance;*** and,
e. ***if the determination in step d proves true, ignoring the individual measurement and basing a current Kalman filter estimate of said length of tape on said reel on other measurements and on previous Kalman filter estimates.***

The amended claim 35 teaches a method that determines whether a measurement of a variable (e.g., r_m), which is related to estimating a length of tape on a reel, has a corresponding variance (e.g., σ^2_m) greater than a maximum acceptable variance. If so, the measurement is ignored and a Kalman filter's current estimate of a length of tape on a reel is based on other measurements and on previous Kalman filter estimates.

As noted with respect to amended claim 34, measured radius values in the cited AAPA are never ignored based on the value of their corresponding variance. Further, there is no disclosure in either Hermanns or Macchia that hints or otherwise suggests of ignoring a measured radius if its corresponding measured variance is greater than a maximum acceptable variance. As previously discussed with respect to claim 34, the existence of statistical variances in general is legally insufficient to render obvious their specifically claimed uses in the tape system in claim 35. Accordingly, the Applicants respectfully submit that independent claim 35 is allowable in its present form.

Claim 36: Claim 36, as amended, comprises in part:

> a. ***choosing a variable to be measured, said variable related to estimating said length of tape on said reel;***
> b. ***selecting a minimum and maximum acceptable measurement value of said variable;***
> c. ***obtaining an individual measurement of said variable;***
> d. ***determining if a three sigma-interval around said individual measurement is not at least partially included within an interval from said minimum to said maximum acceptable measurement values;*** and,
> e. ***if the determination in step d proves true, ignoring the individual measurement and basing a current Kalman filter estimate of said length of tape on said reel on other measurements and on previous Kalman filter estimates.***

The amended claim 36 teaches a method that determines whether a measurement of a variable (e.g., r_m), which is related to estimating a length of tape on a reel, has a three-sigma interval around the measurement that is not at least partially included within the bounded range of acceptable measurements. If so, the measurement is ignored and a Kalman filter's current estimate of a length of tape on a reel is based on other measurements and on previous Kalman filter estimates.

As noted with respect to amended claim 34, measured radius values in the cited AAPA are never ignored based on whether a three-sigma interval around the measurement is not at least partially included within a bounded range of acceptable measurements. Further, there is no disclosure in either Hermanns or Macchia that hints or otherwise suggests of ignoring a measured radius if a three-sigma interval around the measurement is not at least partially included within a bounded range of acceptable measurements. As previously discussed with respect to claim 34, the existence of statistical variances in general is legally insufficient to render obvious their specifically claimed uses in

the tape system in claim 36. Accordingly, the Applicants respectfully submit that independent claim 36 is allowable in its present form.

Claims 37-41: Applicants respectfully submit that the claimed inventions depend on independent claims 35 or 36, and therefore are allowable for at least the same reasons. Based on reasons previously discussed herein, Applicants further submit that the subject matter claimed in amended claims 37-41 is not disclosed by the prior art of record, taken alone or in combination, and thus the claimed inventions are also allowable on their own merits.

Claim 42: Newly added claim 42 comprises in part:

> ***measuring an angular position of said tape reel;***
> ***measuring a length of said tape which is unwound from or wound onto said tape reel during a regular time interval;*** and,
> ***estimating, by a processor that employs a Kalman filter including a mathematical model, said length of said tape on said tape reel in response to said measured angular position of said tape reel and said measured length of said tape*** which is unwound from or wound onto said tape reel during a regular time interval.

As noted in the discussion of amended claim 1, the cited prior-art Kalman filters output state-variable estimations (e.g., VCORR, d_{ok} and δ_k) that would make no sense in a tape system. That is, a Kalman filter configured to estimate a sheave velocity correction, a yarn thickness or an initial bobbin diameter would have no utility in a tape system, such as in the cited AAPA tape system. Therefore, the Kalman filters in Hermanns and Macchia cannot anticipate or render obvious the Kalman filter in claim 42 which explicitly estimates the length of tape on a tape reel in a tape system.

Further, the prior-art Kalman filters are responsive to different input measurements than the claimed Kalman filter. For example, a Kalman filter in Hermanns is responsive to a measured bobbin diameter (d_{sp}) and to one of a measured winding time (t_{sp}) and a measured number of revolutions (n_{sp}). See Hermanns, Col. 4, lines 40-53. A Kalman filter in Macchia is responsive to an instantaneous sheave velocity measurement (IVEL). See Macchia, Col. 5, lines 30-59. In contrast, the claimed Kalman filter is responsive to a completely different set of input measurements specific to a tape system, as explicitly recited in amended claim 1. Accordingly, one of ordinary skill in the art of designing a cable-processing apparatus (Macchia) or a textile machine (Hermanns) would not contemplate a Kalman filter which is input an angular position measurement of a tape reel and a measured length of tape unwound from or wound onto the tape reel during a regular time interval, as recited in claim 42.

As noted, the Kalman filters taught in Hermanns and Macchia are not configured to operate in a tape system. Thus, simple substitution of the low-pass filter in the AAPA tape system with either of these prior-art Kalman filters cannot result in the Applicants' claim 42. Further, there is no apparent reason why an artisan in the field of tape systems would even look to the teachings of Hermanns or Macchia for implementing a Kalman filter in place of the low-pass filter in the AAPA tape system. In fact, a designer of the AAPA tape system likely would not be in possession of references pertaining to textile machines and cable-processing apparatuses. Moreover, because the Kalman filters in Hermanns and Macchia are implemented in environments completely unrelated to a tape system, one of ordinary skill in the art would find no motivation in the cited references to

modify either of these prior-art Kalman filters to accept tape-system input measurements and output estimated quantities of tape, as recited in claim 42.

Accordingly, the Applicants respectfully submit that claim 42 is allowable over the cited references, whether taken singly or in combination.

In sum, all claims in their present form are believed to be in condition for allowance and favorable action is respectfully solicited.

Please charge any additional fee occasioned by this paper to our Deposit Account No. 03-1237.

Respectfully submitted,

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